

# Precise Measurements of the Density and Critical Phenomena near the Phase Transitions in Helium using High-Q Niobium Microwave Cavities

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The experimental approach of using high-Q niobium microwave resonators ( $Q \sim 10^{10}$ ) to achieve precise measurements of density and critical phenomena in liquid helium near phase transitions will be described. The combination of the high precision in frequency measurements (a few parts in  $10^{15}$ ), fine temperature resolution ( $\sim 10^{-10}$ K) and temperature stability ( $\sim 10^{-9}$ K) provides the capability of achieving state-of-the-art density resolution (one part in  $10^{11}$ ) and measurements of physical properties much closer to the phase transitions in helium. The experimental system and the algorithm for deconvoluting the helium density profile in the cavity have been developed and will be described. Estimates of the improved precisions by applying this technique will be given for the critical exponents and amplitude coefficients near  $T_\lambda$ , as well as the critical dynamics near the tricritical point of the  $^3\text{He}$ - $^4\text{He}$  mixtures.